7 EQUIPMENT CHARACTERISTICS

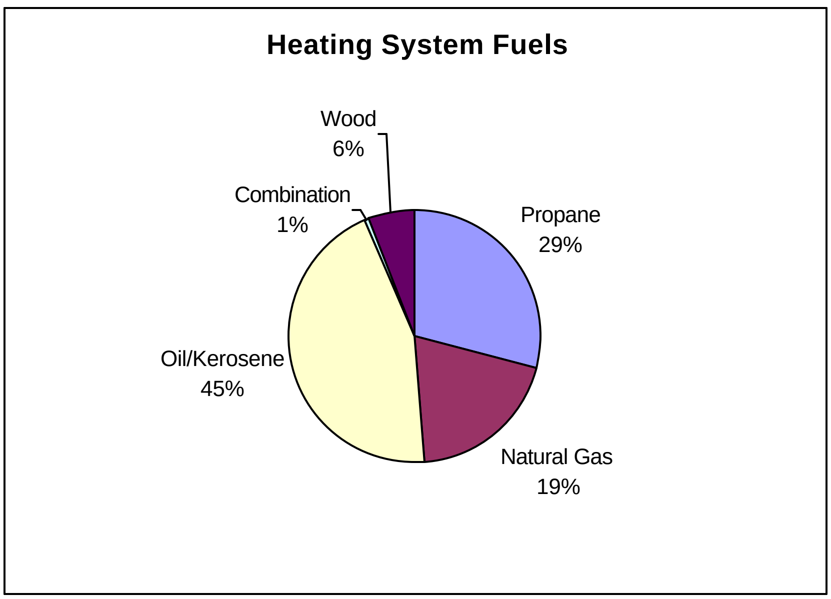
This section discusses the survey results related to equipment and fuel choices for space and water heating.

7.1 SPACE HEATING SYSTEMS

HEATING SYSTEMS

As also found in the 1995 baseline study and the telephone survey, oil is the predominant heating fuel, with 45% of the homes using oil or kerosene as the primary fuel. The primary central heating systems used propane in 29% of the homes, natural gas in 19%, wood in 6%.[1]

Figure 7.1: Primary Heating System Fuels



Most of the 154 homes with complete system information have hydronic systems (83%, 126 homes), with 67% of those homes selecting baseboard, 21% radiant and the remainder a combination of the two. Furnaces were the central system of choice in 22 homes (14%). These results are consistent with the 1995 baseline survey. Boilers were much more likely to be fueled by oil, while furnaces were more commonly designed for propane or natural gas.

Forty-five percent of the homes (61) have a secondary heating system, with wood stoves the most common (in 32 homes), followed by propane or natural gas stoves (16 homes), space

[1] These percentages are based on 154 homes. We were unable to ascertain the primary heating fuel for four homes.

heaters (6 homes) including two homes with electric space heaters, and fossil fuel central systems used as secondary systems in seven homes.

About half of the central heating plants were sealed combustion, and over half were direct vent. Only one home with a furnace had unsealed ducts outside of the conditioned space. Four homes had uninsulated distribution systems outside of the conditioned space.

The vast majority of the central heating systems have an AFUE above the minimum code requirement of .80. More than half of the systems are in the mid range of .83 to .87. For furnaces, almost half are in the two bottom bins and the rest in the highest efficiency category, possibly reflecting the relative scarcity of mid range efficiency furnaces on the market.

Overall, there is an improvement in efficiencies since the 1995 study. The minimum AFUE was raised from .70 to .78 and the median increased from .84 to .85.

Table 7.1: AFUE of Central Systems

	All Systems		Boilers		Furnaces		Manufactured Homes	
Range	#	%	#	%	#	%	#	%
Total Homes	140		120		20		24	
< 0.780	0	0%	0	0%	0	0%	0	0%
0.780 to < 0.800	5	4%	0	0%	5	25%	5	21%
0.800 to < 0.830	27	19%	24	20%	3	15%	8	33%
0.830 to < 0.870	78	56%	78	65%	0	0%	11	46%
0.870 to < 0.910	18	13%	18	15%	0	0%	0	0%
>= 0.910	12	9%	0	0%	12	60%	0	0%
Minimum	0.780		0.802		0.780		0.780	
Maximum	0.930		0.890		0.930		0.862	
Median	0.850		0.850		0.910		0.821	
Mean	0.850		0.848		0.865		0.821	

Most homes (80%)[2] had more than multiple heating zones, ranging from two to eight zones. Less than half of the homes (43%) had at least one setback thermostat.

7.2 HEATING SYSTEM SIZING

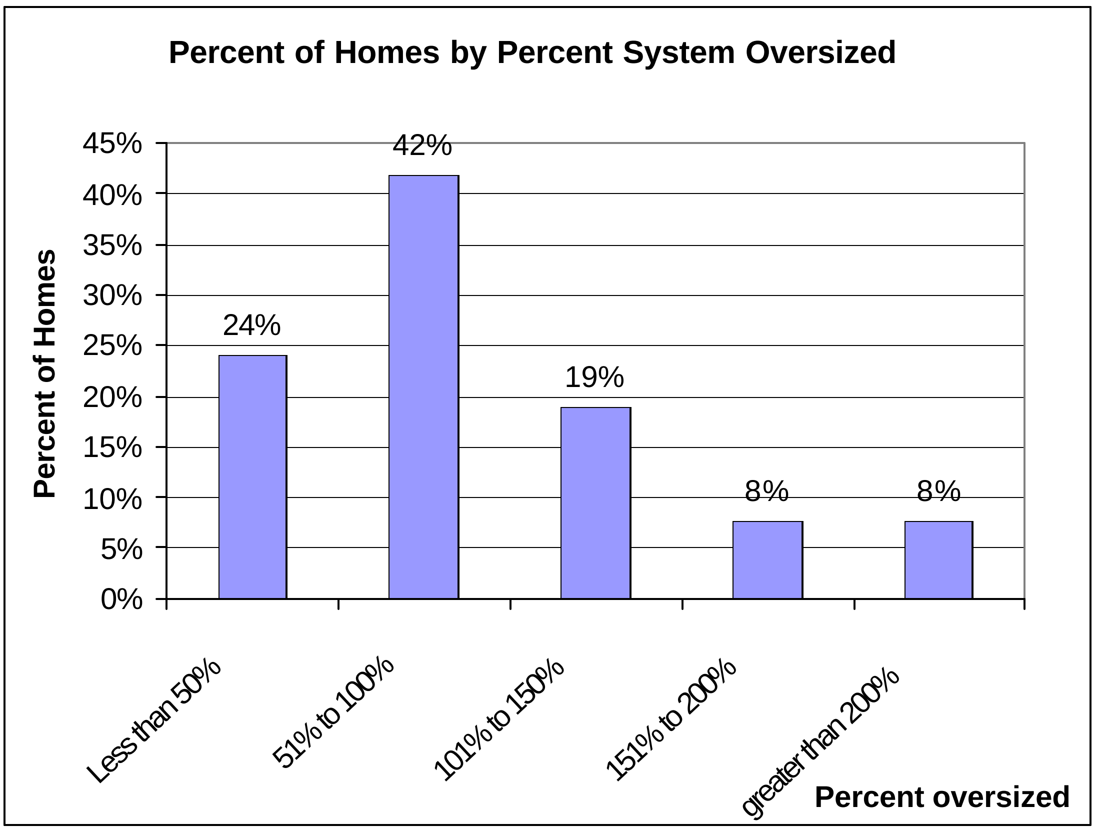
HEATING SYSTEM SIZING

[2] These numbers do not include the efficiency program participants where only partial data was collected since this information was not available from the program database.

We compared the sizing of the heating system output to the design load requirement for 117 homes in the sample. If domestic hot water was also provided by the system, i.e., integrated or tankless coil, the DHW load was added to the design load. Systems were considered correctly sized (oversizing percent is 0) if they were at or near 125% of the design load.

As in the 1995 baseline study, heating systems were consistently oversized.[3] Only 7 of the 117 or 6% were correctly sized. The graph in Figure 7.2 breaks out the homes into bins depending on the output capacity of the heating equipment as a percentage of the calculated maximum load.

Figure 7.2: Heating System Sizing



The median oversizing was 81%, approaching twice as much heating output as required by the load plus 25%. Only 7% of the homes had systems that were properly sized, as opposed to 35% with systems that are more than twice as large as needed. Excessive oversizing of the heating system results in a reduction in seasonal efficiency. This market trend highlights the potential for efficiency improvements by promoting the correct sizing of heating equipment.

[3] Defined as (System Output – (Design load * 1.25))/(Design load * 1.25)

For the most part, as shown in Table 7.2, oversizing is fairly consistent across fuel type. Natural gas may be the one exception, and this result may be attributed both to the VGS New Construction Program and the availability of lower capacity equipment for gas.

Many of the same issues mentioned in the 1995 study contribute to the oversizing of boilers and furnaces. Equipment is not made for homes with very small design loads. Gas and LP Boilers start at outputs of 30,000 while oil boilers have minimum outputs of 56,000 BTU's. There are a few natural gas and propane furnaces available with outputs below 30,000 BTU.[4] However, the lack of smaller equipment does not explain the huge gap in the output of the installed equipment in comparison to the design load. The major factor in system oversizing is likely to be the tendency of contractors to oversize the equipment.

Table 7.2: Average Heating System Oversizing

Fuel Type	Oil	LP	NG	Kerosene	All
# of Homes	59	38	14	5	116
Design Load	53,394	41,870	43,111	32,390	47,604
System Output	118,920	96,536	87,857	68,000	106,618
Average Oversize	95%	107%	69%	85%	95%

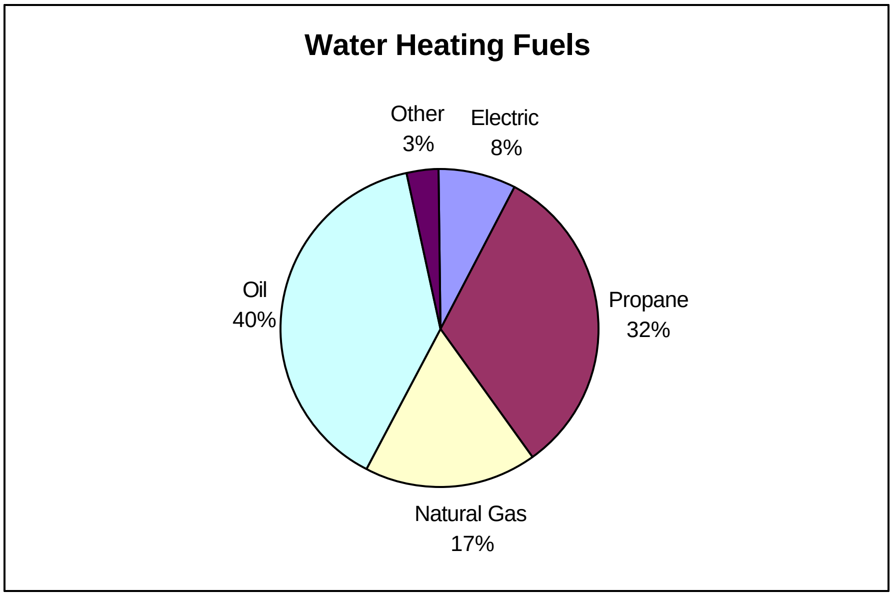
7.3 WATER HEATING

DHW SYSTEMS

As for space heating systems, oil was the most commonly chosen fuel for water heating, with 40% of the homes using oil, followed by propane with 32%, natural gas with 17%, electric (8%) and the remainder split among wood, kerosene and solar (one home). The penetration of electric tanks closely matches the 1995 baseline study.

[4] GAMA directory April 2001.

Figure 7.3: Water Heating Fuels



The incidence of electric water heaters occurs much more frequently in manufactured housing than in the general sample. Seven of the twelve homes with electric DHW were found in manufactured homes, and these seven homes represent almost 40% of the eighteen manufactured homes included in the survey.

Integrated, indirect fired tanks dominated (76% of the homes), with stand alone tanks accounting for 20%, tankless coils at 3% and on demand (1%). This distribution represents a remarkable improvement from the 1995 study, in which almost 30% of the water heaters were low efficiency tankless coils. Since the RBES code does not specific minimum efficiency standards for hot water systems, this result may be related to other economic factors, such as the degradation of tankless coil systems due to the mineral-laden water common in Vermont, in addition to a trend toward greater efficiency.

Comparing the hot water system with the heating plant shows that integrated, indirect-fired tanks were installed with 90% of the boilers.

Table 7.3: DHW and Heating System Types

	DHW System				
Heating Plant	Integrated	On Demand	Stand Alone	Tankless Coil	Totals
Boiler	120	0	8	5	133
Furnace	0	1	22	0	23
Totals	120	1	30	5	

The overall result of this trend is greater efficiency in hot water production. Of the 132 systems with known efficiency, average energy factor was .75. Table 7.4 provides a breakout of efficiency ranges by system type and fuel type for the 132 systems with complete DHW system information.

Table 7.4: DHW Energy Factors

System Type	# of	Average Energy Factor	Median	Minimum	Maximum
Integrated	109	77%	77%	70%	81%
Oil	56	77%	77%	72%	80%
LP/NG	53	76%	77%	70%	81%
Stand Alone	23	70%	64%	50%	91%
LP & NG	15	60%	61%	50%	76%
Electric[5]	8	88%	88%	86%	91%

[5] Energy Factors for electric stand alone tanks do not account for inefficiencies in the production or distribution of electricity. Consequently they are not directly comparable to oil and gas efficiencies, which have a greater similarity in terms of distribution and production.